

Health Hazards from Exposure to Mycotoxic Fungi in Indoor Environments

By Kimberly H. Kirkland

At the AIHCE conference in Orlando on May 25, 2000, a forum was held to summarize the findings of a panel of scientists established as a subcommittee of the AIHA Indoor Environmental Quality Committee. The panel's mission was to evaluate scientific literature that suggests causal associations of adverse health effects with indoor exposure to mycotoxic fungi. The review panel was comprised of experts in pulmonary pediatrics, occupational health, epidemiology, microbiology, medical microbiology, toxicology and industrial hygiene.

Airborne Toxigenic Fungi

Brian Shelton of PathCon Laboratories, Norcross, Ga., chaired the session and provided an overview of the controversy surrounding *Stachybotrys* and other mycotoxic fungi. The presence of mycotoxic fungi in buildings and the perceived threat to human health have caused some investigators to take extreme measures that can be costly in both personnel and financial resources. On the other hand, some investigators do not consider these extreme measures necessary based on the current scientific literature.

One study was based on the Centers for Disease Control's investigation of a cluster of infants with pulmonary hemorrhage in Cleveland. This study initially reported an association with mycotoxins and pulmonary hemosiderosis. These findings gained a great deal of media attention—stories of *Stachybotrys* and adverse health effects were reported in *USA Today Weekend* and the *New York Times*, as well as on the Internet and on television, including CBS's *48 Hours* and *CNN Health Story*—and greatly increased public fear. Widespread media attention and initiatives of some investigators have resulted in significant numbers of court cases, expensive class action law suits, evacuation of buildings and homes and abandonment of personal possessions.

There is no debate that exposures to fungi

in indoor air can cause irritation, hypersensitivity reactions and infections. Ingestion of mycotoxins in agricultural settings is widely accepted as a cause of health problems. The debate centers on recent statements that inhalation of mycotoxins from indoor air poses a serious health hazard resulting in a wide variety of health effects.



Figure 1. Close-up of a petri-plate with Rose-Bengal Agar showing growth of *Penicillium*, *Aspergillus* and others. (Photo used with permission from PathCon Laboratories.)

The controversy for industrial hygienists stems from limited peer reviewed scientific literature evaluating associations of health effects with inhalation of toxigenic spores in indoor environments. The panel was charged with critically reviewing the scientific literature and subsequently evaluated original peer-reviewed studies that alleged adverse health effects from inhaled mycotoxins as a result of indoor air exposures. Reviewed papers included the following:

- Croft, Jarvis and Yatawara: Airborne outbreak of trichothecene toxicosis. *Atmos. Environ.* 20:549-552 (1986).
- Johanning, Biagini, Hull, Morey, Jarvis, et al.: Health and immunology study following exposure to toxigenic fungi (*Stachybotrys chartarum*) in a water-damaged office environment. *Int. Arch. Occup. Environ. Health* 68:207-218 (1996).
- Hodgson, Morey, Leung, Morrow, Miller, et al.: Building-associated pul-

monary disease from exposure to *Stachybotrys chartarum* and *Aspergillus versicolor*. *J.O.E.M.* 40:241-249 (1998).

- Etzel, Montana, Sorenson, Kullman, Miller, et al.: Acute pulmonary hemorrhage in infants associated with exposure to *Stachybotrys atra* and other fungi. *Arch. Pediatr. Adolesc. Med.* 152:757-762 (1998).

For each of these papers, Shelton gave a brief synopsis, including the study design, number of study subjects and reported symptoms. An important finding of this review was the wide variety of symptoms described in each paper and the association of all of them with exposure to mycotoxic fungi. For example, when combined these four papers reported the following symptoms: chronic fatigue, cough, cold and flu, immune disorders, malaise, headaches, lung disease, asthma, pulmonary hemorrhage, gastrointestinal illness and death.

The purpose of the review was to assess exposure to mycotoxic fungi and ultimately to answer the question, "Do toxins associated with these fungi in indoor settings result in increased frequency, severity or spectrum of illness?"

A Medical Perspective

Alan Cohen of the Georgia Pediatric Pulmonary Association, Atlanta, and a member of the CDC external review panel of the Cleveland investigation, presented clinical aspects of idiopathic pulmonary hemosiderosis.

Cohen evaluated the supposed association between *Stachybotrys* exposure in indoor settings and IPH in infants. One of the greatest problems with identifying an outbreak of IPH is the lack of a clear, concise and consistent case definition. Also, IPH is not defined by specific clinical, histological or laboratory findings. IPH is a nonspecific pathological condition of bleeding of any source or type in the lung. Cohen explained how IPH is a very poorly understood and a rare disorder with no known cause or etiology, which made the cluster in Cleveland highly unusual.

Cohen presented eight major limitations with the grouping of cases in the Cleveland study of 1993-1996. The limitations are as follows:

- No clear case definition or diagnostic

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criteria to meet.

- No consistency in historical data collection or medical examinations to exclude other causes.
- No consideration of obvious risk factors, including drug use, premature birth, chemical exposure and infanticide.
- Non-blinded and inconsistent data collection, biased sampling and flawed statistical analysis.
- Ignoring unique characteristics in case series, i.e., the young age of infants, multiple environmental exposures and hemolysis.
- No evaluation of other household members to discount other common environmental exposures. Why did none of the siblings or adults have any obvious symptoms despite a common exposure source?
- No evaluation of adult household members to screen for antibodies to fungi.
- No evidence of microbiological or serological colonization, infection or invasion to the alleged toxigenic fungi.

Toxicology, *Stachybotrys* and the Industrial Hygienist

Coreen Robbins of GlobalTox Inc., Redmond, Wash., discussed the role of animal toxicology in evaluating health effects of individuals exposed to *Stachybotrys* spores in indoor environments. Robbins reviewed some of the widely cited papers in the animal literature used to support the concept that mycotoxin exposure in indoor air is responsible for adverse health effects. It is difficult to relate many of these studies to indoor exposure to mycotoxins because the studies use short-term high levels of exposure, whereas in the real world the majority of mycotoxin exposure is at intermittent low levels. Robbins emphasized, "Dose makes the poison."

Sheldon Rabinovitz of Sandler Occupational Medical Associates, Rockville, Md., further emphasized that industrial hygienists should rely on toxicology, dose-response relationships and exposure identification to make conclusions regarding health complaints and possible fungal exposure.

Epidemiology

Dana Flanders of the Emory School of Public Health in Atlanta presented an epidemiological evaluation of the literature on toxigenic fungi. He emphasized small effective sample size as a key limitation among many of the frequently cited studies of toxigenic fungi. When an exposure to groups of people is relatively similar and the outcome is not independent, then the effective sample size is determined by the number of groups or buildings studied



Figure 2. Photomicrograph of *Stachybotrys chartarum*, a mycotoxin producing fungus at the heart of the current controversy. (Photo used with permission from PathCon Laboratories.)

rather than the number of individuals. Because these toxigenic fungi studies involve exposures of groups of people, the real sample size depends heavily on the number of groups.

For example, many studies of toxigenic fungi involve only a few floors in the same building or possibly a complaint and a non-complaint building; therefore, the effective sample size is typically very low, only one or two. Most of these studies also have a small effective sample size because the majority of the outcomes are not independent of one another, i.e., malaise, fatigue, headache and flu-like symptoms may be due to a commonality or a psychogenic illness potential among building occupants. A small effective sample size severely limits the extent to which the findings can be generalized to a population.

The second major failing of the literature on toxigenic fungi is that despite there being at least four frequently cited studies supporting an association, they cannot be combined and evaluated as a

whole because they address different outcomes or use different case definitions. These studies cannot be weighted and evaluated as a group because they are not referring to the same outcome or illness.

Implications for the Practice of Prevention

Don Millar of Don Millar and Associates, Atlanta, specifically addressed the controversy as it relates to the public health mission of prevention.

Prudent prevention requires minimizing unnecessary exposure to all fungi. Although it is widely accepted that exposure to airborne fungi is potentially hazardous because they can cause allergies, irritation and sometimes infections, the controversy stems from the association between toxigenic fungi and the wide variety of reported symptoms. No current data suggest special remediation practices are required for toxigenic fungi, including *Stachybotrys*. As published in the March 10, 2000, *MMWR Report*, the CDC repudiated the association between *Stachybotrys chartarum* and acute pulmonary hemorrhage.

Ultimately, the panel concluded that at this time there is not enough evidence to support an association between mycotoxic fungi and a change in the spectrum of illness, the severity of illness or an increase in risk of illness.

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Technical Exchange is a feature offering a forum to discuss real-life experiences in technical areas. These experiences are informational and are not peer reviewed; however, submissions are reviewed for technical accuracy. They are intended to help I/Hs share information for the benefit of all industrial hygiene professionals.

Readers are encouraged to submit summaries of case studies, new technology, problem-solving and other experiences they may encounter through the course of their work. Send submissions to Lisa Junker, The Synergist, 2700 Prosperity Ave., #250, Fairfax, Va. 22031; fax (703) 207-3561; ljunker@aiha.org. Submissions will be edited for space and clarity.